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The relative importance of mean and turbulent wind parameters on aeolian sediment transport

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The majority of predictive sand transport models are founded on cubic power relationships between the transport rate and shear velocity (u_*) that are time independent. These models have achieved a limited degree of success and subsequent research has been conducted into a broad range of factors known to affect the transport rate. In particular, recent attention has focused on the modelling and measurement of sand transport by temporally varying winds which may induce unsteady or discontinuous saltation through time. Recent research carried out in the aeolian community has questioned our reliance on time averaged flow parameters and has called for an improved understanding of the role turbulence or high frequency turbulent structures may play in sediment transport systems.

The relative importance of differing mean and turbulent wind parameters on aeolian sediment flux over a topographically flat, dry, sandy surface was examined in the Skeleton Coast National Park, northwest Namibia. Continuous, synchronous measurements of wind velocity, using sonic anemometers positioned at heights between 2.2 m to 0.15 m, and of horizontal sand transport, using saltation impact sensors known as Safires at 0.05 m above the ground surface, were made at a sampling frequency of 10 Hz. Mean wind parameters and mass sand flux were measured using cup anemometers and wedge shaped sand traps respectively.

Traditional mean measures of fluid flow including horizontal windspeed (U) and u_* are compared to key measures of turbulence and turbulent stress (Reynolds stress; instantaneous horizontal and vertical fluctuations, u' and w'; coherent flow structures defined from quadrant analysis) with respect to their association with mean and instantaneous sediment flux. Results demonstrate that u_* fails to adequately characterise

sand transport dynamics, particularly as the averaging time is decreased. A similar conclusion is made for time averaged Reynolds shear stress. However, horizontal wind speed correlates well with sand transport even with short averaging times. Quadrant analysis revealed that turbulent events with a positive u' component, such as sweeps and outward interactions, were responsible for the majority of sand transport. In contrast, despite ejections (negative u' component) occurring with a similar frequency to sweep events, they resulted in little sand transport.